



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NASIENRIGLYN

NASIONALE SERTIFIKAAT

INGENIEURSWETENSKAP N4

1 April 2025

Hierdie nasienriglyn bestaan uit 12 bladsye.

VRAAG 1: ALGEMEEN

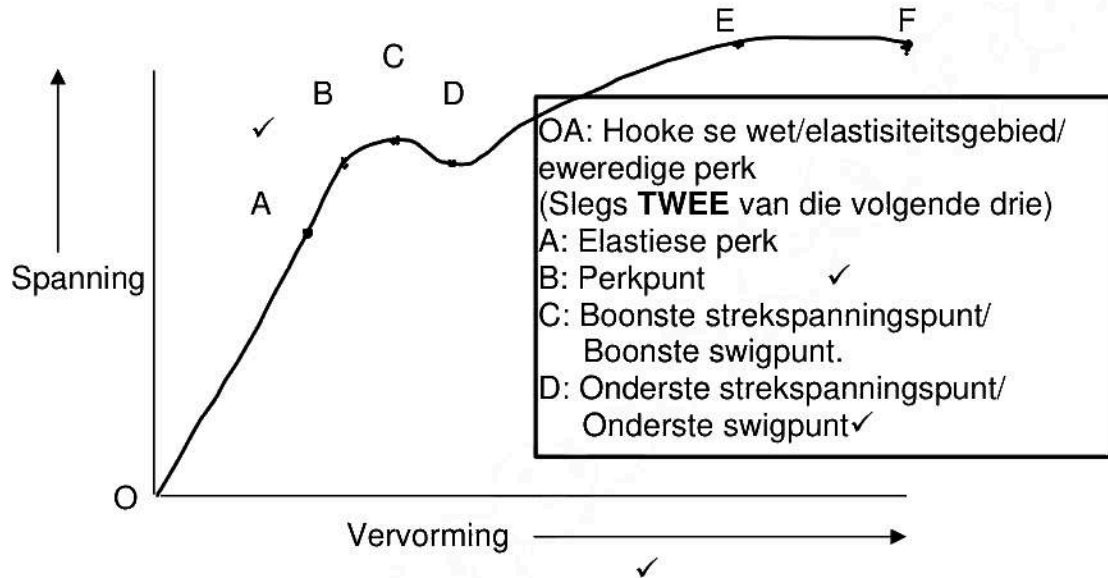
1.1 1.1.1 In 'n gegewe massa gas wissel die druk direk met die absolute temperatuur van die gas wanneer die volume konstant bly. ✓✓

1.1.2 Die voorwerp sal in beweging of in rus wees tensy 'n eksterne krag daarop inwerk. ✓✓

(2 × 2)

(4)

1.2



- = y-as spanning, = x-is vervorming
- OB – reguitlyn met byskrifte
- C – boonste swigpunt
- D – onderste swigpunt met byskrifte

(4)

1.3 Absolute druk is die som van die meterdruk en atmosferiese druk.

(1)

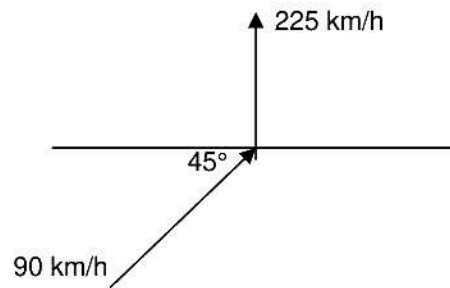
- 1.4
- Om hidrouliese energie te akkumuleer en dit onderbroke te vergroot.
 - Dit help om rimpel te verminder.
 - Dien as hidrouliese skokbreker.
 - Mag as primêre kragbron vir klein hidrouliese stelsels gebruik word.
 - Verskaf voldoende krag om een of meer funksies te voltooi. (Enige 1 × 1)

(1)

[10]

VRAAG 2: KINEMATIKA

2.1



$$\begin{aligned} \Sigma H &= 90 \cos [45^\circ] \\ &= 63,641 \text{ km/h, Oos} \end{aligned}$$

$$\begin{aligned} \Sigma V &= 225 + 90 \sin [45^\circ] \\ &= 288,641 \text{ km/h, Noord} \end{aligned}$$

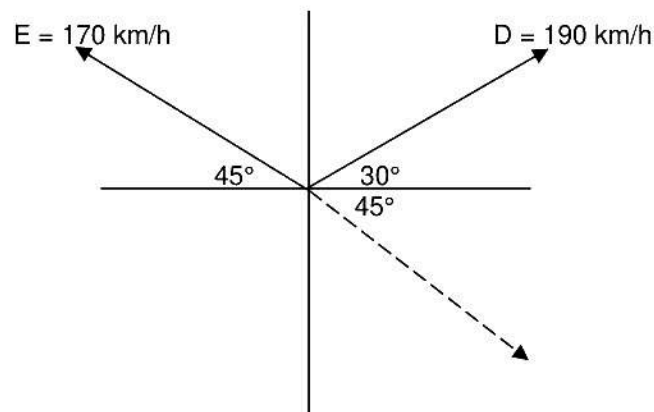
$$\begin{aligned} R &= \sqrt{(63,641)^2 + 288,641^2} \\ &= 295,534 \text{ km/h} \checkmark \end{aligned}$$

$$\begin{aligned} \theta &= \tan^{-1} (288,641/63,641) \\ &= 77,566^\circ \checkmark \end{aligned}$$

$$\therefore R = 295,534 \text{ km/h, E } 77,57^\circ \text{ N} \checkmark$$

(3)

2.2



$$\sum H C = 190 \cos [30^\circ] + 170 \cos [315^\circ]$$

$$= 284,753 \text{ km/h, Oos} \checkmark$$

$$\sum V C = 190 \sin [30^\circ] + 170 \sin [315^\circ]$$

$$= 25,208 \text{ km/h, Suid} \checkmark$$

$$R = \sqrt{(284,753)^2 + 25,208^2}$$

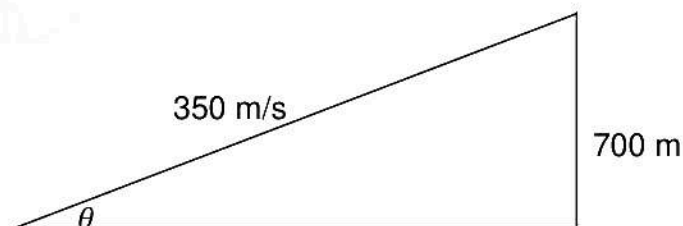
$$= 285,867 \text{ km/h} \checkmark$$

$$\theta = \tan^{-1} \left(\frac{25,208}{284,753} \right)$$

$$= 5,06^\circ \text{ S} \checkmark$$

Snelheid van D relatief tot E = 285,867 km/h, O 5,06° S (5)

2.3



$$S = ut - \frac{1}{2}gt^2$$

$$700 = (350 \sin \theta)(6) - \frac{1}{2}(9,8)(6)^2 \checkmark$$

$$(700 + 176,4)/2100 = \sin \theta \checkmark$$

$$\theta = \sin^{-1} [0,4173]$$

$$\theta = 24,67^\circ \checkmark$$

(3)
[11]

VRAAG 3: HOEKBEWEGING

- 3.1 $m = 1\,200\text{ kg}$
 $d = 2\,000\text{ cm}$
 $r = 10\text{ m}✓$
 $s = 5\,000\text{ cm} = 50\text{ m}$
 $v = 110\text{ km/h} = 30,556\text{ m/s}$

$$\begin{aligned} 3.1.1 \quad \omega &= v/r \\ &= 30,556/10✓ \\ &= 3,056\text{ rad/s}✓✓ \end{aligned} \quad (3)$$

$$\begin{aligned} 3.1.2 \quad \theta &= s/r \\ &= 50/10✓ \\ &= 5\text{ radiale}✓ \end{aligned} \quad (2)$$

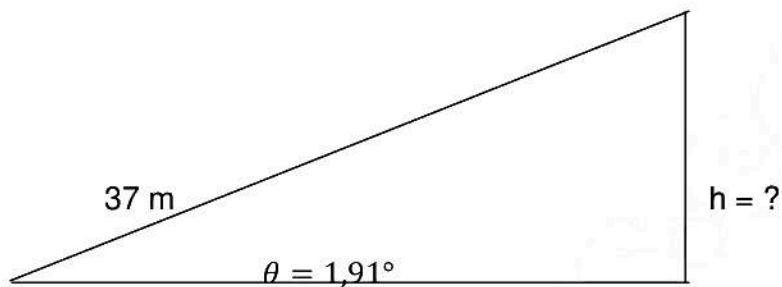
- 3.2 $T = 700\text{ Nm}$
 $P = 70\text{ kW} = 70\,000\text{ W}$

$$\begin{aligned} P &= 2\pi NT \\ N &= P/2\pi T✓ \\ &= (70\,000)/(2\pi \times 700)✓ \\ &= 15,916\text{ rev/s}✓ \end{aligned} \quad \begin{matrix} (3) \\ \mathbf{[8]} \end{matrix}$$

VRAAG 4: DINAMIKA

4.1 $u = 75 \text{ km/h} = 20,833 \text{ m/s}$
 $v = 0 \text{ m/s}$
 $S = 37 \text{ m}$
Helling = $1,910^\circ$

$$\begin{aligned} K_{(e)} (\text{horisontaal}) &= \frac{1}{2} mv^2 \\ &= \frac{1}{2} \times m \times 20,833^2 \\ &= 217,007 \text{ m}\checkmark \end{aligned}$$



$$\begin{aligned} h = \text{hoogte} &= 37 \sin [1,91^\circ] \\ &= 1,233 \text{ m}\checkmark \end{aligned}$$

Totale energie by die top = P_e

$$\begin{aligned} P_e &= mgh \\ &= m \times 9,8 \times 1,233\checkmark \\ &= 12,083 \text{ m}\checkmark \end{aligned}$$

$$K_e \text{ tydens daling} = \frac{1}{2} mv^2$$

Die totale energie wat deur die remme geabsorbeer word, bly konstant.

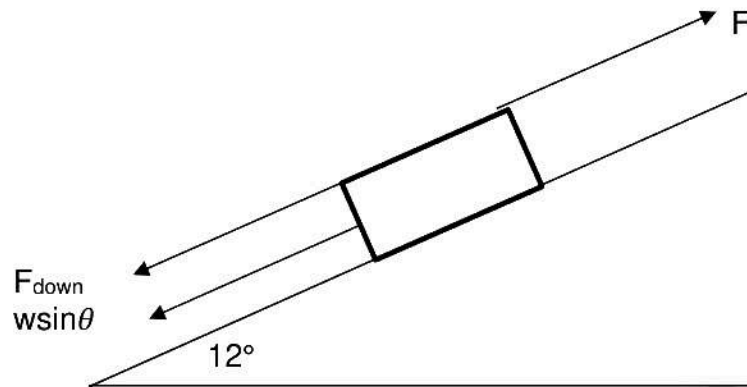
$$K_e (\text{horisontaal}) = P_e \text{ by die top} + K_e \text{ tydens daling}$$

$$\begin{aligned} 217,007 \text{ m} &= 12,083 \text{ m} + 0,5 mv^2\checkmark \\ 0,5v^2 &= 217,007 - 12,083\checkmark \end{aligned}$$

$$V = 20,245 \text{ m/s}\checkmark$$

(7)

4.2 $V = 9 \text{ m/s}$



$$\begin{aligned} F_{Tot} &= F_{\mu} - w \sin \theta \\ &= 550 - 180 \times 9,8 \times \sin [12^\circ] \checkmark \\ &= 183,244 \text{ N} \checkmark \end{aligned}$$

$$\begin{aligned} P &= F_{Tot} \times v \\ &= 183,244 \times 9 \checkmark \\ &= 1649,196 \text{ W} \checkmark \end{aligned}$$

(4)
[11]

VRAAG 5: STATIKA

5.1 5.1.1 Beskou momente om M

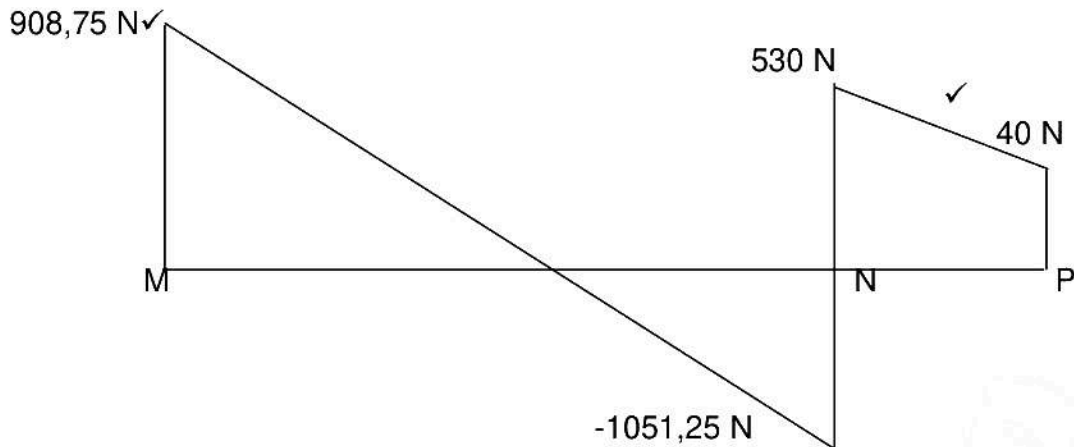
$$\begin{aligned} \sum \text{[kloksgewyse momente]} &= \sum \text{[antikloksgewyse momente]} \\ (2450 \times 5) + (40 \times 10) &= (N \times 8) \\ N &= 1581,25 \text{ N} \checkmark \end{aligned}$$

Beskou momente om N

$$\begin{aligned} \sum \text{[kloksgewyse momente]} &= \sum \text{[antikloksgewyse momente]} \\ (40 \times 2) + (M \times 8) &= (2450 \times 3) \checkmark \\ M &= 908,75 \text{ N} \checkmark \end{aligned}$$

(3)

5.1.2



(2)

5.1.3 $BM \text{ by } O = (908,75 \times 5) + (-1225 \times 2,5)$
 $= 1481,25 \text{ Nm} \checkmark$

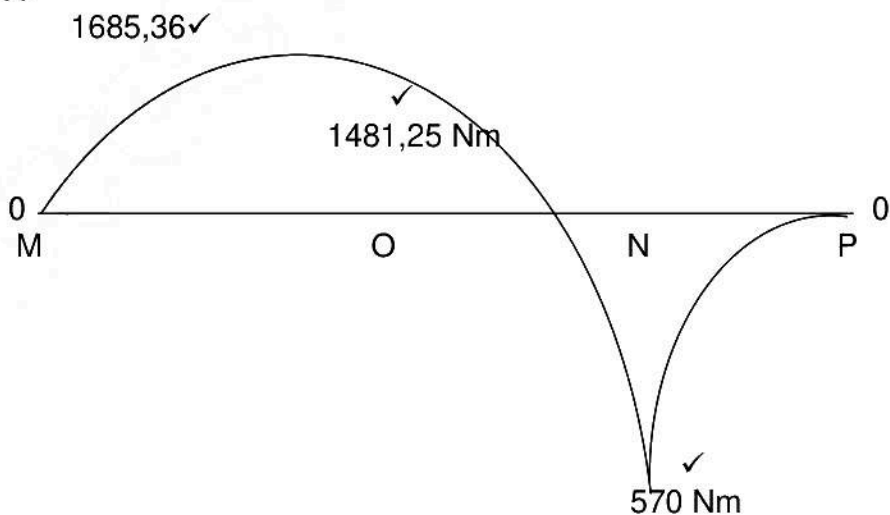
$BM \text{ by } N = (908,75 \times 8) + (-1960 \times 4)$
 $= -570 \text{ Nm}$

$\sum F_e = 0$
 $908,75 - 245 \times x = 0$
 $x = 3,709 \text{ m} \checkmark$

Maksimum $BM = 908,75 \times 3,709 - 245 \times 3,709 \times (3,709/2)$
 $= 1685,36 \text{ Nm} \checkmark$

(3)

5.1.4



(3)

5.2

Vorm	Oppervlakte (mm ²)	Sentroïed (mm)	AC (mm ³)
	$l \times b = 40 \times 100$ $= 4000$	$C = l/2$ $= 100/2 \checkmark$ $= 50$	4000×50 $= 200\,000$
	$l \times b = 80 \times 150$ $= 12\,000$	$C = L_1 + L_2$ $= 100 + 80$ $= 180$	$12\,000 \times 140$ $= 1\,680\,000$
	$\sum A = 4000 + 12\,000$ $= 16\,000 \checkmark$		$\sum AC = 200\,000 + 1\,680\,000$ $= 1\,880\,000 \checkmark$
	$y = (\sum AC) / (\sum A) = 1\,880\,000 / 16\,000$ $= 117,5 \text{ mm} \checkmark$		

(4)
[15]

VRAAG 6: HIDROULIKA

6.1 SL = 150 mm = 0,15 m
d = 150 mm = 0,15 m
D = 300 mm = 0,3 m
E = 250 N

6.1.1 $W_R / F_p = D^2 / d^2$
 $W_R = (F_p \times D^2) / d^2$
 maar $MA = F_p / F_h$
 $F_p = F_h \times MA \times \eta / 100 \checkmark$
 $= 250 \times 20 \times 92 / 100$
 $= 4\,600 \text{ N} \checkmark$

$W = (4600 \times 0,3^2) / 0,15^2 \checkmark$
 $= 18\,400 \text{ N} \checkmark$
 $= 18,4 \text{ kN}$

(4)

6.1.2 SL = 470 mm = 0,47 m
 $\eta = 92\%$

$n = (D^2 \times H) / (d^2 \times SL)$
 $= ([0,3]^2 \times 0,47) / (0,15 \times 0,15) \checkmark \checkmark$
 $= 12,533 \approx 13 \text{ slae} \checkmark \checkmark$

6.2 C = 3
SL = 510 mm = 0,51 m
d = 0,3 m
P = 850 kPa

$$\begin{aligned} 6.2.1 \quad V_s &= A \times SL \times C \times N/60 \\ &= (\pi \times (0,3)^2)/4 \times 0,51 \times 3 \times 480/60 \checkmark \\ &= 0,8651946168 \text{ m}^3/\text{s} \checkmark \end{aligned}$$

$$\begin{aligned} P &= 850 \times 10^3 \times (0,8651946168) \\ &= 735415,424 \text{ W} \checkmark \end{aligned} \quad (3)$$

$$\begin{aligned} 6.2.2 \quad V_a &=? \\ \text{Glip} &= 8\% \\ \eta &= 100 - \text{Glip}\% \\ &= 100 - 8 \\ &= 92\% \\ t &= 20 \text{ s} \\ V_s &= 0,86519461,68 \text{ m}^3/\text{s} \end{aligned}$$

$$\begin{aligned} V_a &= V_s \times \eta/100 \\ &= 0,86519461,68 \times 92/100 \checkmark \\ &= 0,7959790475 \text{ m}^3/\text{s} \checkmark \end{aligned}$$

$$\begin{aligned} \text{In 20 sekondes } V_a &= 0,7959790475 \times 20 \checkmark \\ &= 15,921 \text{ m}^3 \checkmark \end{aligned}$$

OF

$$\begin{aligned} \text{Glip}\% &= (V_s - V_a)/V_s \\ 0,08 &= (0,86519461,68 - V_a)/0,86519461,68 \\ \llbracket - V \rrbracket_a &= 0,08 \times 0,86519461,68 - 0,86519461,68 \checkmark \\ V_a &= 0,7959790475 \text{ m}^3/\text{s} \checkmark \end{aligned}$$

$$\begin{aligned} \text{In 20 sekondes } V_a &= 0,7959790475 \times 20 \checkmark \\ &= 15,921 \text{ m}^3 \checkmark \end{aligned}$$

(4)
[15]

VRAAG 7: SPANING EN VERVORMING

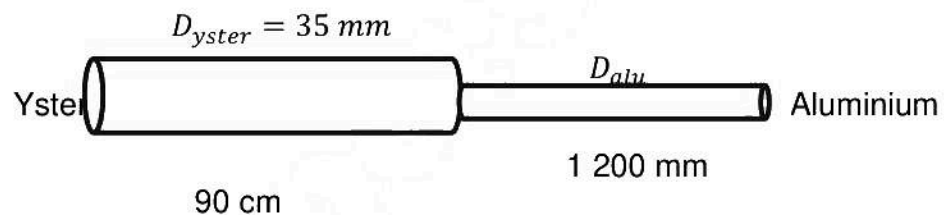
7.1 Elastisiteit is die vermoë van 'n stof of materiaal om na die oorspronklike vorm of grootte terug te keer wanneer die vervorming verwyder word.✓✓ (1 × 2) (2)

7.2 $F = 320 \text{ kN} = 320\,000 \text{ N}$
Spanning = $10 \text{ MPa} = 10\,000\,000 \text{ Pa}$

$$\begin{aligned}\text{Spanning} &= \text{Krag/Oppervlakte} \\ \text{Oppervlakte} &= \text{Krag/Spanning} \\ &= 320\,000/10\,000\,000 \checkmark \\ &= 0,032 \text{ m} \checkmark\end{aligned}$$

$$\begin{aligned}\text{d.i. } L \times L &= 0,179 \\ &= 0,179 \text{ m} \checkmark \\ &= 179 \times 179 \text{ mm}\end{aligned}\quad (4)$$

7.3 Gegee:



$$E_{aluminium} = 200 \text{ GPa}; E_{yster} = 250 \text{ GPa}; F = 40 \text{ kN}$$

$$\begin{aligned}7.3.1 \quad \sigma_{alu} &= \frac{40\,000}{\frac{\pi \times 0,025^2}{4}} \checkmark \\ &= 81,487 \text{ MPa} \checkmark\end{aligned}\quad (2)$$

$$\begin{aligned}7.3.2 \quad \sigma_{alu} &= \frac{40\,000}{\frac{\pi \times (0,035)^2}{4}} \checkmark \\ &= 41,575 \text{ MPa} \checkmark\end{aligned}\quad (2)$$

$$\begin{aligned}7.3.3 \quad \Delta x_{alu} &= \frac{40\,000 \times 1,2}{\frac{\pi (0,025)^2}{4} \times 200 \times 10^9} \checkmark \\ &= 0,489 \times 10^{-3} \text{ m} \\ &= 0,49 \text{ mm} \checkmark\end{aligned}$$

$$\begin{aligned}\Delta x_{alu} &= \frac{40\,000 \times 0,9}{\frac{\pi (0,035)^2}{4} \times 250 \times 10^9} \checkmark \\ &= 0,1497 \times 10^{-3} \text{ m} \\ &= 0,1494 \text{ mm} \checkmark\end{aligned}$$

$$\begin{aligned}\text{Totale verlenging} &= 0,1497 + 0,49 \\ &= 0,6397 \checkmark\end{aligned}$$

(5)
[15]

VRAAG 8: WARMTE

8.1 Die uitsettingskoëffisiënt van oppervlakte is die verandering in 'n oppervlakte per eenheid oppervlakte per verandering van 1 °C in temperatuur.✓✓
(Enige 1 × 2) (2)

8.2 $A_0 = 3^2 = 9 \text{ m}^2$
 $t_1 = 40 \text{ °C}$
 $d = 700 \text{ mm} = 0,7 \text{ m}$
 $\alpha = 13 \times 10^{-6} / \text{°C}$
 $A_f = 3,05^2 = 9,3025 \text{ m}^2$

$$\begin{aligned} 8.2.1 \quad \Delta A &= A_f - A_0 \\ &= 9,3025 - 9 \\ &= 0,3025 \text{ m}^2 \checkmark \end{aligned}$$

$$\begin{aligned} \Delta A &= A_0 \times 2\alpha \times \Delta t \\ 0,3025 &= 9 \times 2 \times 13 \times 10^{-6} \times \Delta t \checkmark \\ \Delta t &= 1292,735 \text{ °C} \checkmark \end{aligned}$$

$$t_2 = 1292,735 \text{ °C} + 40 \text{ °C} = 1332,735 \text{ °C} \checkmark \quad (4)$$

$$\begin{aligned} 8.2.2 \quad \Delta A &= A_0 \times 2\alpha \times \Delta t \\ &= 0,3849 \times 2 \times 13 \times 10^{-6} \times 1292,735 \checkmark \\ A_0 &= \pi \cdot [0,7]^2 / 4 = 0,3849 \text{ m}^2 = 0,0129 \text{ m}^2 \checkmark \end{aligned}$$

$$\begin{aligned} A_f &= 0,0129 + 0,3849 \\ &= 0,3978 \text{ m}^2 \checkmark \end{aligned}$$

$$\begin{aligned} d &= \sqrt{(4(0,3978))/\pi} \\ &= 0,712 \text{ m} \checkmark \end{aligned} \quad (4)$$

8.3 $m = 4 \text{ g} = 0,004 \text{ kg}$

$$\begin{aligned} 8.3.1 \quad P_1 V_1 &= nRT_1 \\ P_1 \times 0,003 &= 0,004 \times 287 \times 309 \checkmark \\ P_1 &= 118\,244 \text{ Pa} \\ P_1 &= 118,244 \text{ kPa} \checkmark \end{aligned} \quad (2)$$

$$\begin{aligned} 8.3.2 \quad P_1 V_1 &= (2P_1 V_2) / T_2 \\ 0,003 / 309 &= [2V_2] / 409 \checkmark \\ V_2 &= 0,0019854 \checkmark \\ &= 1,985 \times 10^{-3} \text{ m}^3 \checkmark \end{aligned} \quad (3)$$

[15]

TOTAAL: 100